



U.S. Integrated Ocean Observing System (IOOS) Implementation
Southern California Coastal Ocean Observing System (SCCOOS)
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Eric Terrill, Principal Investigator
SCCOOS Technical Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0214, La Jolla, CA 92093
Phone: 858-822-3101 E-mail: eterrill@ucsd.edu

Julie Thomas, Co-Investigator
SCCOOS Executive Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0214, La Jolla, CA 92093
Phone: 858-534-3034 E-mail: jthomas@ucsd.edu

Clarissa Anderson, Co-Principle Investigator
SCCOOS Executive Director
Scripps Institution of Oceanography, University of California, San Diego
9500 Gilman Drive, Mail Code 0206, La Jolla, CA 92093
Phone: 858-246-2226 E-mail: clrander@ucsd.edu

Proposal Partners:

California Polytechnic State University, San Luis Obispo
Farallon Institute for Advanced Ecosystem Research
University of California, Los Angeles (UCLA)
University of California, Santa Barbara (UCSB)
University of Southern California (USC)

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1. PROGRESS AND ACCOMPLISHMENTS

Governance

SCCOOS operates as a system of collaborative partnerships and contractual agreements with scientists and researchers from universities and organizations in Southern California that contribute data and research to the ocean observing system. SCCOOS program staff facilitate this collaboration as well as overall organizational management, planning, and development. SCCOOS staff also contribute to national, state-wide, regional, and local efforts with the other IOOS Associations, and the U.S. Integrated Ocean Observing System (IOOS). Program staff and lead scientists will work closely with all of the five US Pacific Observing Systems, particularly emphasizing their relationship with the Central and Northern California Ocean Observing System (CeNCOOS), Northwest Association of Networked Ocean Observing Systems (NANOOS), and the West Coast Governors Alliance on Ocean Health to collaborate on west coast initiatives, data collection, informational products, and future priorities.

SCCOOS has aligned its mission and organizational goals with the focus areas designated by U.S. IOOS and IOOS Associations. Examples on how SCCOOS carried out their mission over the last 5 years are below;

- Work with stakeholders and users to identify their data product needs and determine the best methods for communicating results to the community.
- Provide coastal managers and decision makers with science-based information for management decisions.
- Provide coastal ocean data and information to the general public.
- Develop, evaluate, and optimize products designed for short-term decision-making and long-term environmental assessments.
- Expand outreach and education efforts to create classroom education programs, teacher workshops, and informal learning opportunities based on ocean observing data and information.

Data Management and Communication

SCCOOS continues to have the ability to achieve its milestones by providing access to high-quality integrated data and support regional user needs while complying with the standards and protocols for sharing and archiving data that are developed nationally. SCCOOS actively participates in IOOS Data Management efforts such as the Thematic Real-Time Environmental Distributed Data Services (THREDDS). By leveraging the Coastal Data Information Program (CDIP) and the HF Radar National Network programs, SCCOOS targets THREDDS distribution for wave, surface currents and most recently, shore station data including OA measurements and a fixed mooring with measurements down into the water column. SCCOOS also continues to implement QARTOD data quality control standards. All data have associated ISO 19115 compliant metadata.

Certification

As of this year, SCCOOS became a Certified Regional Information Coordination Entity, or RICE, a non-federal observing organization recognized as meeting federal standards for data gathering and management. In addition, certification requires that the organization operate inclusively, transparently,

and seeking user input to determine system priorities. Throughout this process, SCCOOS has successfully implemented data quality control and archival procedures on two types of observing systems, the Automated Shore Stations (Stearns Wharf, Newport, Scripps Pier), and the Burkolator at the Carlsbad Aquafarm. These data follow QARTOD quality control standards and are being archived through NCEI.

Ecosystems and Climate Milestones

1. Operate and maintain a network of glider lines to collect measurements of temperature, salinity, chlorophyll, current velocity, dissolved oxygen and acoustic backscatter; deliver data to SCCOOS website and push to modeling centers.
 - a. Completion date: Milestone complete yet glider operations continue
 - b. Status is complete: Autonomous underwater gliders developed over the past several years sustain fine resolution observations of the coastal ocean. As used off southern California, Spray profiles to 500 m or to the ocean bottom, whichever is shallower. Line 90 has been occupied essentially continuously since October 2006 (SCCOOS funds about 80% of this glider line). Data plots are available in near real-time through both <http://spray.ucsd.edu/> and the SCCOOS web site <http://sccoos.org/>. Data is made immediately available to assimilating models at UCLA and at Scripps. Also, KKY files are sent to the Naval Oceanographic Office for assimilation into their suite of models. Work has been done to create a standard CF-compliant netcdf format for glider data. This format allows for exchange between US glider operators, submission to a glider data assembly center, and subsequent distribution to GTS. Data is sent in netcdf to the ERDDAP group at NOAA SWFSC. In turn, ERDDAP makes the data publically available, and forwards the data through a national glider data assembly center to NDBC for distribution on GTS. Access to delayed mode quality controlled data is provided through password-protected accounts on sushi.ucsd.edu. Recent users of this data include the Orange County Sanitation District and UC Santa Cruz.
 - c. Successes: The California Glider Network CGN has grown through the support of various agencies and foundations, and has contributed to a number of projects. The CGN is currently completely supported by NOAA, with past support from the state of California, and the Gordon and Betty Moore Foundation (GBMF). Line 80, in particular has been a nexus of cooperating projects primarily through the NSF-funded California Current Ecosystem (CCE) LTER. Through the NOAA-funded Consortium for the Ocean's Role in Climate (CORC), glider data is being assimilated into a model of the SCB. Such assimilating models are powerful tools for compositing coastal observations.
2. Conduct shipboard observations with CalCOFI surveys; post online.
 - a. Completion date: Milestone complete yet nearshore CalCOFI cruises continue
 - b. Status is complete: As part of CalCOFI-LTER program, SCCOOS displays parameters that are measured in the 9-nearshore stations at the 20-m isobath in Southern California including temperature, salinity, zooplankton, phytoplankton, fish eggs and invertebrate larvae. These data are posted online.
 - c. Successes: In 2004, SCCOOS started funding 9 nearshore stations to CalCOFI's standard 66 station pattern. As a result of this partnership hydrographic data and phytoplankton data are deposited within three months of generation on the SCCOOS data server for public access. NOAA's SWFSC provides the larval data and serve the data to the public using their data servers.

3. Publish survey reports and maps of seabird species' distribution and abundance on SCCOOS web site.
 - a. Completion date: Milestone complete yet seabird observations continue
 - b. Status is complete: In this SCCOOS component, our 29-year (1987 - present) record of seabird observations, conducted in conjunction with the long-term California Cooperative Oceanic Fisheries Investigations CalCOFI and California Current Ecosystem Long-Term Ecological Research (CCE-LTER) programs is augmented. Under the auspices of SCCOOS, the distribution and abundance of seabirds during three seasonal surveys were studied. Survey reports and maps of species' distribution and abundance are published on SCCOOS website.
 - c. Successes: Over the years, seabird observations have become an integral part of the CalCOFI/CCE-LTER program by providing information on upper trophic levels which complements the hydrographic and lower trophic level (plankton) data regularly collected by others as part of this program. The seabird studies also contribute to public appreciation of the SCCOOS program. Information on seabird distributions and abundance are useful to marine spatial planning (MSP) and assessment of other anthropogenic forcing of this marine ecosystem. Due to their existence at the boundary layers of the atmosphere and the ocean, seabirds are the most conspicuous of all marine organisms which rely on surface and near-surface ocean habitats. Seabirds also are less exploited than other upper level predators such as fish and mammals. Owing to these and other characteristics, seabirds have been put forth as reliable ecological indicators of coupled physical-ecological change.

Water Quality Milestones

1. Monitor Harmful Algal Blooms (HABs) at five pier stations by collecting weekly measurements of temperature, salinity, chlorophyll, nutrients and toxic species. Provide data online and distribute via the California HABMAP listserv.
 - a. Completion date: Milestone complete yet HAB monitoring continues
 - b. Status is complete: The SCCOOS Harmful Algal Bloom (HAB) program complements the statewide HAB Monitoring and Alert Program (HABMAP) that was initiated by NOAA, the California Ocean Science Trust, and SCCWRP. SCCOOS together with CeNCOOS has extended the HAB network along the California coast, and provides science-based weekly HAB and phycotoxin monitoring at several locations in southern and central California. SCCOOS HABs webpage includes Central and Northern California. Weekly reports are derived from a year long time series of sampling for HAB species and related water quality measurements and are provided to the California HABMAP Group. *Pseudo-nitzscha* blooms that produce domoic acid are being monitored. The Caron lab at the University of Southern California (USC), is responsible for the analysis of domoic acid from the 5 SCCOOS HAB monitoring sites.
 - c. Successes: The SCCOOS HAB program contributes to the statewide HAB Monitoring and Alert Program (HABMAP) initiated by NOAA, the California Ocean Science Trust, and the Southern California Coastal Water Research Project (SCCWRP). The HAB program generates a baseline time-series of ocean properties to monitor ocean conditions in the very near shore zone of the Southern California Bight. These measurements are used to ground truth forecast models for short term warnings. They also increase our knowledge of the sign, frequency and magnitude of variation of temperature, salinity, density, nutrients and pollutants.
2. Implement the 3-km ROMS ocean forecasting system for real-time operations statewide; conduct a systematic validation of the 3-km statewide ROMS.

- a. Completion date: Milestone Complete yet CA 3-km ROMS operations continue
 - b. Status is complete: SCCOOS and CeNCOOS partner to maintain a real-time nowcast/forecast system over the entire California coast. The modeling system is based on the Regional Ocean Modeling System (ROMS) with a spatial resolution of 3-km and 40 vertical layers. This ROMS configuration has the data assimilation capability based on the 3-dimensional variational (3DVAR) scheme. SCCOOS and CeNCOOS principal investigators work together to carry out a systematic model validation effort, so as to identify the weakness of the model, data assimilation and nowcast/forecast for future improvements
 - c. Successes: This state-wide ROMS model is assimilating both the HF radar surface current data and the vertical profiles of temperature and salinity from four Spray gliders as well as other available observational data sets including satellite sea surface temperature and vertical profiles of temperature and salinity from moorings, ships and floats. In addition to the display at the SCCOOS web site, static ROMS images are being displayed on Yi Chao's website; west.rssoffice.com. You can also find ROMS validation images against three assimilated data sets there as well (HF Radar, Gliders). There also is a published a skill assessment of the model using observational platforms (Chao et al., 2017 <https://doi.org/10.1016/j.dsr2.2017.04.013>).
3. Analyze pollution dispersal in finescale, nearshore, and shelf ROMS for the San Pedro and Santa Monica Bays.
 - a. Completion date: Milestone complete yet analyses continue
 - b. Status is complete: A Regional Oceanic Modeling System (ROMS) is under development for realistic simulation of currents, surface gravity waves, dissolved materials, larvae, and suspended sediments in the transition region across the continental shelf from deep-water flows to the shoreline (i.e., Submesoscale ROMS, SROMS). The goal is to understand how wind-, tide-, river-, and wave-driven currents are mutually related in topographically complex regions, and how they combine to transport materials including pollutants, sediments, biogeochemicals, and plankton. Particular attention is given to intrinsically variable currents (mainly submesoscale fronts and vortices) that are inherently unpredictable by down-scaling from operational regional data-assimilative models.
 - c. Successes: Several sites in the Southern California Bight, in particular Huntington Beach, Santa Monica Bay, Santa Barbara Channel, and Channel Islands have applications being built. This project is being done using two tactics; 1) Exploit the surface wave -- current interaction and grid- nesting capabilities of ROMS to examine cross-shore exchange of materials in the shelf and surf zone. Sites near Pt. Conception, the northern Channel Islands, Santa Monica Bay, and the Newport region are the foci, and 2) Develop a coupled ROMS/biogeochemistry/ecosystem model to aid the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles, as well as variability and trends in hypoxia and acidification. The progress is posted [online](#).
 4. Continue automated sampling at four shore stations to measure temperature, salinity, chlorophyll, turbidity and water level.
 - a. Completion date: Milestone complete yet operations continue
 - b. Status is complete: The only exception is the Santa Monica Shore Station, that station remains decommissioned (since 7/13/2015). Calibration samples have been collected during cleaning and service dives, however incorporation of data quality checks from 4 stations is not feasible

at the current funding level. SCCOOS stakeholders have been given permission to provide funds to get the Santa Monica Shore Station, but unfortunately it is not enough funding to get the shore station back online. SCCOOS is still discussing with the interested partners for sustained funding.

- c. Successes: The automated shore stations program now operates and maintains 3 stations (Scripps Pier, Newport Pier and Santa Barbara Pier) and provide real-time continuous data at 1-4 minute intervals with limited interruptions. Automated shore station data are one of the most requested data sets provided through SCCOOS. These data are used by the public and local state and research agencies (e.g. [Heal the Bay](#), [Santa Monica Bay Restoration Commission](#), [Hyperion](#), [LA WaterKeeper](#), etc.) to assess local conditions related to water quality, nearshore processes, population dynamics of coastal species and harmful algal blooms.

Marine Operations Milestones

1. Annually provide training to first responders of maritime incidences in the use of SCCOOS products.
 - a. Completion date: Milestone complete yet training continues
 - b. Status is complete: SCCOOS participates in training and science education to a broad range of stakeholders either by request or as opportunity arises.
 - c. Successes: Near real-time data products from the system are used for a number of different efforts, but not limited to: assessment of ecosystem trends, long term trends, oil spill response, regional ocean modeling, search and rescue, storm water discharges and outfall tracking, and vessel traffic aids. SCCOOS regularly communicate with stakeholders by staying actively engaged to all the above stakeholders at meetings, conferences, exercises, etc., which lends itself to continuous collaborations.
2. Operate and maintain the network of short, medium and long-range HF radar systems and deliver data streams to the National HFR Network.
 - a. Completion date: Milestone complete yet operations continue
 - b. Status is complete: SCCOOS HF Radar systems are maintained by four operators: University of California, San Diego, Scripps Institution of Oceanography; University of Southern California; University of California, Santa Barbara; and California Polytechnic State University, San Luis Obispo. HF radar data are aggregated, and HF radar derived surface current maps are distributed for all RAs as well as global partners.
 - c. Successes: SCCOOS leverages the High Frequency Network (HFRNet) program for total vector calculations, online visualization, data access via web services, and radial and total vector archiving. The live feed of HF radar data are available on the national HFR network for oil and hazardous spill response in the Environmental Response Management Application® (ERMA) map viewer for the southwest region. Near real-time and archived surface current measurements have been used in the National Preparedness for Response Exercise Program (NPREP) drill scenarios led by the U.S. Coast Guard in San Diego, Los Angeles and Ventura.
3. Maintain and expand integrated, customized products with multi-layer views of observations, nowcasts and forecasts. Collaborate with the Port of Long Beach to maximize the benefit of SCCOOS observations.
 - a. Completion date: Milestone complete yet operations continue

- b. Status is complete: HF radar derived surface currents are assimilated into the UCLA run Regional Ocean Modeling System (ROMS) which is displayed in an interactive, multi-layer visualization in nowcast and hindcast. Additionally, users have the ability to display forecast trajectories through the "drop a drifter" tool to visualize potential paths of surface following objects/substances. The Coastal Data Information Program (CDIP) is funded through NOAA/IOOS to operate and maintain a customized, interactive map display of ocean conditions and forecasts for the Port of Los Angeles and Long Beach Harbor is used to improve navigation, safety and efficiency for commercial vessels, harbor pilots and port operations.
- c. Successes: SCCOOS uses CDIP's project to create an in-kind effort to reach out and educate local, state, and federal agencies, resource managers, industry, policy makers, educators, scientists, non-governmental organizations, and the public. SCCOOS goal is to grow awareness around the importance of ocean observations, and provides in-kind support to CDIP's project.
- 4. Deliver glider data for assimilation into models including US Navy coastal models.
 - a. Completion date: Milestone complete yet operations continue
 - b. Status is complete
 - c. Successes: Near real-time glider data are provided to the Naval Oceanographic Office (NAVO) for assimilation into operational models.
- 5. Deliver surface current data and surface wind analyses to aid spill response, SAR real-time recovery and post analysis trajectories.
 - a. Completion date: milestone complete yet operations continue
 - b. Status is complete
 - c. Successes: Surface current measurements and surface wind analyses are integrated into the General NOAA Operational Modeling Environment (GNOME) for oil spill trajectory analysis. Customized and expanded interactive map displays of wave and surface currents with multi-layered views of observations, nowcasts, and forecasts were developed for Naval Air Systems Command (NAVAIR), at Point Mugu. Implementation of surface currents measured by the SCCOOS HF radar network are now accessible by U.S. Coast Guard for search and rescue (SAR) applications using their Environmental Data Server.

Coastal Hazards Milestones

- 1. Develop Shoreline inundation forecast, validation, and dissemination of warnings. Display inundation development and integration information online. Expand development and integration of inundation web site.
 - a. Completion date: Milestone complete yet operations continue
 - b. Status is complete: The goal of this project is to develop and distribute customized model products concerning ocean beach erosion, ocean front flooding, and alongshore transport. Surveys of sand levels on beaches and monitor storm inundations at selected locations are posted on the SCCOOS website. These data are used to validate and refine coastal data and forecast models of erosion, flooding, and inundation levels can be used to protect and improve beaches, real estate, and highways.
 - c. Successes: Recommendations for monitoring and modeling to improve product confidence and accuracy will be provided. Website content will be updated as information and model improvements become available. Model-based inundation nowcasts and forecasts, and warnings, will be disseminated to users via Internet and email. City

managers will provide feedback on model accuracy and format, and contribute qualitative observations acquired by their staff. End users include city planners and the National Weather Service.

2. SCOPE OF WORK

SCCOOS operates as a system of partnerships and projects that are facilitated by technical and programmatic staff. Organized by the four focus areas, the SCCOOS scientific and technical approach is based on a system of core ocean observing technologies and the delivery of useful data products and tools. System components include sub-surface ocean observations from underwater gliders, nearshore and coastal measurements, wave measurements and models, pier-based monitoring, satellite imagery, high frequency (HF) radar surface current mapping and data assimilative ocean modeling. The projects described in this report represent the multi-disciplinary and collaborative efforts of the research teams that contribute data and information to SCCOOS.

3. PERSONNEL AND ORGANIZATION STRUCTURE

Dr. Clarissa Anderson became the Executive Director of SCCOOS on January 1, 2017. Julie Thomas was Executive Director until January 2017, and after that point became a SCCOOS Senior Advisor.

4. BUDGET ANALYSIS

FY11-16 funding has provided a valuable investment in important assets and will strengthen regional partnerships and national program planning. SCCOOS is also committed to contributing to larger ocean observing efforts regionally, nationally, and internationally. FY 2016-2017, SCCOOS received a no cost extension for this award, and has been spent out.

5. ENVIRONMENTAL COMPLIANCE

a. First Responder Training

IOOS/NOAA determined this project has a categorical exclusion, and their statement is as follows: The aforementioned project will not result in any changes to the human environment. As defined in Section 6.03c3(d), Administrative r Routine Program Functions, of NAO 216-6, this project involves conference room and/or classroom training activities that hold no potential for significant environmental impacts. As such, they should be categorically excluded from the need to prepare an Environmental Assessment or an Environmental Impact Statement.

b. Gliders

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows: It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

c. Shore Stations

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows: It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its

potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

d. Vessel Sampling – CalCOFI

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows: It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

e. Mooring

IOOS/NOAA determined this project has No Significant Impact, and their state is as follows: It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review. The project and its potential impact may be limited through the following terms or conditions placed on receipt of NOAA funds:

- A permit is in place to allow the mooring to reside in its location: Below is the permits for the Del Mar Mooring Activities under the subject award.
- SCCOOS projects have implemented the Essential Fish Habitat Conservation Recommendations provided by NMFS on July 7, 2014 to avoid, minimize, or offset effects of this activity.